THE STATUS OF STATISTICS IN OHIO'S SECONDARY SCHOOLS

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For more than sixty-five years mathematics educators have been advocating the inclusion of statistics and probability in the secondary school curriculum. during the past decade virtually every blue-ribbon committee studying the mathematics curriculum has called for more emphasis on these subjects. Yet a recent survey by the authors indicates that only a few of Ohio's high schools offer significant instruction in statistics or probability. As a consequence, most students who graduate from Ohio high schools have little competence in probability and statistics.

As early as 1923 the National Committee on Mathematical Requirements, in its report on The Reorganization of Mathematics in Secondary Education, recommended fundamental statistical concepts, simple frequency distributions with graphic representations of various kinds, and measures of central tendency as topics for grades 10 – 12. Forty years later the "new math" movement emphasized probability, to be treated as a branch of pure mathematics.

In 1967 a Joint Committee on the Curriculum in Statistics and Probability was formed by the American Statistical Association and the National Council of Teachers of Mathematics to promote statistical literacy in the nation's secondary schools. An early product of this committee was a book of readings entitled Statistics: A Guide to the Unknown. More recent outcomes are the Statistics Teacher Network Newsletter and the Quantitative Literacy Project.

During the 1980's there has been a growing realization on the part of mathematics educators that statistics and probability should now be considered fundamental for all high school students. In its Curriculum and Evaluation Standards for School Mathematics the National Council of Teachers of Mathematics has included standards for statistics and probability at all levels, from the elementary grades through high school. In particular, the 9 – 12 standards include in the core curriculum for all students, not only descriptive statistics and simple concepts of probability, but such topics as curve fitting, sampling methods,

hypothesis testing and simulation techniques. Moreover, college intending students will be expected to learn about such topics as the normal distribution, chi-square distribution and random variables.

A SURVEY

With these recommendations in mind, the authors surveyed all Ohio high schools in 1987 to ascertain the extent to which statistics and probability are actually being taught in secondary schools. A questionnaire was mailed to 856 public, private and parochial high schools in Ohio. Information requested in the survey included: 1) some demographic data on the school; 2) questions on whether the school offers a separate course on probability and statistics, which students took the course and what it covered; 3) information on what probability and statistics topics are covered in traditional courses like algebra and general math.

Responses were received from 289 schools, for a return of 34%. Among the schools responding to the survey, 82% were public, 15% were private (religious) schools, and 3% were other private schools. Although a large number of schools responded to the survey, there may have been a tendency for schools with some activity in probability and statistics to respond at a higher rate than those schools with little activity in the area. Therefore, if there is any bias in the results, it is likely that our sample shows more presence of probability and statistics in the schools than is actually present in the total population.

From the sample of schools responding to our survey, we estimated the statistics for the entire population of high schools. We present these statistics as percentages, plus or minus a statistical error that represents a 95% confidence interval.

Based on our survey, we estimate that 22 ± 3% (the 95% confidence interval is 19% – 25%) of Ohio's high schools offer a separate course in probability and/or statistics. These are elective courses for college bound juniors and seniors, usually lasting one semester and serving as an alternative to advanced placement calculus. Of the schools that offer a separate course, we estimate that 20 ± 6% offer a year-long course. Some schools, 15 ± 2%, plan to introduce a separate probability and statistics course in the near future.

Nearly all of the separate courses in probability and statistics include descriptive statistics and basic probability. Topics that were reported in at least

80% of these separate courses are: tables and graphs, measures of central tendency and variability, elementary probability, permutations and combinations, conditional probability, normal and binomial probability distributions. Between one-half and three-fourths of these courses cover the central limit theorem and elementary statistical inference topics like estimation, confidence intervals, hypothesis testing, and correlation. On the other hand, fewer than half of these courses include regression, analysis of variance, chi-square tests, or nonparametric statistics.

Surprisingly, we estimate that computers are being used in only 40 ± 7% of the probability and statistics courses. Those reporting computer use typically used an Apple II microcomputer with BASIC approximately five times during the course.

As was expected, the presence of a separate course in probability and statistics was more common in larger schools than smaller schools. For example, 44% of the schools in our sample having a senior class of over 500 students reported offering a separate course, while only 13% of the schools with fewer than 100 seniors did so.

Though a larger percentage (78 ± 3%) of Ohio's schools do not offer a separate probability and statistics course, many do include some statistics and probability in other courses. Topics from descriptive statistics are found in 51 ± 4% of the general math courses, in 29 ± 3% of the pre–calculus courses, but in less than 20% of other courses. Probability, on the other hand, is most likely to be studied in a pre-calculus course (50 ± 3%) in an algebra 2 course (32 ± 3%), or in a general math course (19 ± 3%). Very few schools (less than 15 ± 2%) teach statistical inference outside of a separate probability and statistics course.

Some observations are in order at this point. The early recommendations for statistics in the secondary school curriculum called for only the simplest descriptive statistics, while the new math movement of the 1960's emphasized probability as a topic in pure mathematics. Both of these emphases are evident in the secondary school textbooks and curriculum guides today. Recent reports advocate a broader and deeper coverage of both probability and statistics, but the curriculum has not yet caught up with these recommendations.

Current textbooks provide little support for those teachers who desire to include probability or statistics in their algebra or advanced math courses. For example, most algebra textbooks pay lip service to probability, but it typically appears near the end of the book, in one of those chapters that seldom gets taught.

Moreover, the probability content may comprise only one or two sections (perhaps as little as three pages) of a chapter devoted primarily to permutations and combinations.

While it is encouraging to note that 33 ± 3% of Ohio's schools are either now offering or planning to offer a separate course in probability and statistics, this figure may be inflated by the tendency of schools that are doing something in probability and statistics to respond to the questionnaire. Also 87 ± 2% of the schools are doing at least something in the area of probability and statistics. On the other hand, it is somewhat disconcerting to realize that statistics is most likely to be taught in general math courses where it is seldom seen by college bound students. In fact, college bound students seem more likely to study probability than statistics. Further, it is of concern to realize that at least 13% of the schools in Ohio appear to be doing nothing in the area of probability and statistics.

CONCLUSIONS

Some progress is being made in introducing probability and statistics topics into Ohio's secondary schools; however, more needs to be accomplished. The curriculum should insure that each high school graduate will have a significant exposure to appropriate topics in probability and statistics. In particular, more emphasis needs to be given to elementary statistical inference. Topics like sampling, confidence intervals, bounds on the error in estimation, and control charts are very important as they are commonly encountered in everyday life.

We need to revise the secondary school curriculum to insure that all graduates have competence in both probability and statistics. This goal may be achieved through a separate course in probability and statistics or by integrating these topics into other courses. The important point here is that instruction in statistical concepts should be available to all students.

The above reforms will require the efforts of teachers and administrators responsible for developing the curriculum. They will also require programs in colleges and universities aimed at preparing teachers to offer instruction in statistics and probability. The authors are currently directing a Statistics Teaching Project that will prepare 30 junior high and high school teachers to implement some of these needed changes in their schools. We plan to discuss some of the outcomes of this

project in a future article.

REFERENCES

Kinney, John. Statistics Teacher Network, Rose-Hulman Institute of Technology, 5500 Wabash Avenue, Terre Haute, IN 47803.

Landwehr, J.M. et.al. The Quantitative Literacy Series, Dale Seymour Publications; Palo Alto, California, 1987.

MATH SCRAMBLER

Unscramble these four mixed-up math terms, one letter to each blank:

L I D O S	□□_ _ _
A I T O R	_□□_ _
V I D D I E	□_ _ _□_
T H I G E Y	_ _ _□□_

Now, rearrange the letters in the squares to form the answer to the riddle below:

WHAT TERRY SAID WHEN THEY TOLD HIM THAT 2 IS THE ONLY EVEN PRIME NUMBER:

____ ____ ____ ____ ' ____ ____ ____ ____ !

ANSWER: SOLID RATIO DIVIDE EIGHTY

THAT'S ODD!

Dear Editors:

Do you know what is really wrong with geometry? It's eighth grade algebra. Mash 7th and 8th grade general math together to make room for algebra – squish!, out goes informal geometry! When I was younger we could expect most ninth graders to know the volume of a cylinder, area of a triangle, degrees in a triangle, parallel, perpendicular, protractor, and a whole bunch more. Nowadays all of that kind of stuff has to be taught in the plane geometry course. Which means that a few items are left out, like proof, construction problems which pinned down many geometric concepts, circle theorems, everything three-dimensional, and on and on. Dig up a geometry text of twenty or thirty years ago, compare it to current ones, and you'll see that we've lost half or more. Maybe a third of our college students entering a senior level geometry course haven't heard of something as ordinary as inscribed angles!

If algebra in the 8th grade really accomplished anything I wouldn't complain so loudly.

Veteran Kid Watcher

Dear VKW:

Just relax, Old-Timer, it's about over. The Standards will spread informal geometry throughout the grades, teachers will routinely leave it out, plane geometry will become a unit in Algebra III (the third year of Beginning Algebra), and we'll bring in Japanese and Germans to teach our factory workers about points, lines, planes, circles, and such hi-tech concepts!

The Editors

"ARITHMETIC" – Additions

Ahem. We missed some. Words that can be made using the letters from "arithmetic", that is. We had 145 listed in the last issue of the Journal. To those, add "ahem", "hire", "term", and "their". And these, supplied by Rich Laatsch, Mathematics and Statistics Department, Miami University: theatric, citrate, matcher, tither, attire. That brings the total up to 154. What others have we missed?